Information and the choice for schooling

INFORMATION AND THE CHOICE FOR SCHOOLING

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CONTENTS

ABSTRACT

Information plays an important role in the choice for a school in consideration of securing a certain job. Firstly, the consequences of a decision depend on the state of the labour market after several years. Secondly, a choice has to be made between positions (the jobs) with which one has no experiences. To determine the preferences, a student might use the experiences of others who already participate in the labour market. The consequences of these uncertainties on the allocation on the labour market (wages and distribution between specializations) will be illustrated by some simple models.

I would like to thank Hans Heijke for his helpful comments and supervision.

1. INTRODUCTION

In a normal Walrasian equilibrium model prices are assumed to clear the market, that is, prices are just on the level at which supply equals demand on each market. By assuming prices are always in 'equilibrium', the question how this equilibrium is reached is avoided. Hayek (1945) describes a process of communication by which individual economic subjects achieve the optimal prices. He argues that the prices could be determined by solving algebraicly a system of simultaneous equations, but this presupposes the existence of 'one brain' having the disposal of all the information that is needed. This brain does not exist.

In the theory of Hayek all the economic subjects only have the disposal of their own information. The market system causes an accumulation of the information resulting in an optimal allocation. In this communication process, information has to be send back and forth several times before the equilibrium is reached. However, in most economic situations, this kind of recontracting does not take place. Mostly information can only be sent by real action. A shopkeeper sets the price of a product and the people inform him about the demand at this price by buying or not buying the product. In case the product is perishable and it is bought frequently, the communication process of Hayek can be seen as an approximation of this situation. For products which are only bought once, this communication process is unrealistic.

The choice for schooling is an example of a decision in which this kind of recontracting is not possible. The possibilities for gathering information are very limited, because most choices which will appear in a lifetime only take place once, and also the possibilities of changing from one school to another are limited (whether by institutional, or by time restrictions), so it is far from possible to get all the information needed for a Walrasian equilibrium by experiences.

But the situation is even more complicated, since the choice for schooling has to be made several years before entering the job market. The job that one will get and the wage which is paid for it, will be determined on that labour market. The student has to anticipate the future job market when choosing a school. The choice will, of course, depend on the characteristics

of the education itself and on the future possibilities that are fostered by the education. Examples of the first are the attractiveness of the training, its difficulty and also its costs. Examples of the second type, the future possibilities, are the attractiveness of jobs that can be acquired by this education and the wage that will be paid.

If one's decision depends on the kind of job he will get and on the wage which will be paid to him, he has to make a prediction of those future situations (In an equilibrium context only the wage is important because the job market will be cleared by the wage; In a disequilibrium context also the possibility of getting a certain job is of consequence).

These problems raise the question why there is no market at which students and courses are matched. A market has the property that all the available (relevant) information gets accumulated. The school-market would be a kind of future labour market. In theory this would exclude mismatches that could be foreseen, i.e. the match would be optimal except for the effects of unpredictable random disturbances. In contrast with the labour market such a school-market does (almost) not exist.

An initial impetus to the explanation of this absence, perhaps can be found in the 'option-character' of education. Dothan and Williams (1981) state that 'for many individuals premature commitment to a specific occupation or career can be costly'.[1] These costs not only arise because of the uncertainty about the general conditions on the labour market, but also because 'at an early age the student is often uncertain about his personal preferences, abilities'.[2] This early commitment would, even if it is formulated as a contract with payments depending on the examination results and on choices for specializations after the contract is made, not make optimal use of the individual capacities which are not known beforehand by one of the contracting parties.

These uncertainties are on the other hand an extra difficulty in choosing between courses. The utility somebody will get depends on aspects of a course and of jobs which the student perhaps has never experienced. In the

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1. Dothan and Williams (1981), p. 118.

2. Dothan and Williams (1981), p. 118.

usual theory everybody knows his own utility function. This presumes a constancy of the utility function and decisions that are repeated many times. In occupational choice both are not likely to occur, since, as stated before, the choice is only made once and mostly the choice is connected to the situation in a new stage of life.

All these uncertainties make the choice for schooling a very difficult problem for students. They have to make a choice, which will have important consequences for their further life, but they only have very vague information about these consequences. The combination of great importance together with vague information leaded to a discord in the theory on educational choice. Some authors stress the difficulty of assessing accurate the consequences of the choice for students. They tend to depict the students as naive and myopic. This leads to models in which students are ruled by current wages instead of future wages (Freeman, 1971), optimize their starting salary instead of their life-time income (Freeman, 1976) and give to much weight to their present interests instead of taking into consideration the fact that these will change within their life (Wiegersma, 1961).

Other authors point out that it is not likely that students will get into these pitfalls, since there is an enormous gain possible by making better predictions and by basing their decisions on these predictions. This leads to models in which students base their decisions on rational expectations (Siow, 1984 and Zarkin, 1985). The argument that students are not able to calculate the 'true conditional distribution based on all information available at the time the expectations are formed'[3], is brushed aside with the argument that this inability of the students creates a gap in the market that will be discovered by profit seeking entrepreneurs.

The absence of such enterprises implies, in this view, that students already make the best possible predictions themselves or that the benefits of such predictions do not equal out the costs (pecuniary or non-pecuniary) of the calculation. With a view to the present situation both arguments seem to be unrealistic, but this does not explain why the economic system wastes the

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3. De Jong (1988), p. 444.

scarce information.[4]

In this paper, first, a model will be presented in which students are confronted with a very simple educational choice. This model will serve as a starting point for the subsequent sections. In the third section an exposition is given about the suppositions which have to be made in order to expect student to be able to valuate correctly information about the labour market. Section 4 deals with the information that is incorporated in the behavior of others. In section 5 a model is presented in which the fact that students do not have optimal predictions about the future labour market is taken as given. In this model students do have expectations about the future, but they do not use opportunities to improve this information by aggregation. In section 6 the students do not know their preferences with regard to their future jobs. In order to deal with this problem they observe people who are working already and reveal their 'utility-function' by comparing their own characteristics with the personal characteristics of these people. Finally some conclusions are drawn.

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4. Muth (1961), p. 316. See also Snippe (1986) who states at p. 432 that 'in fact this is the chief rationale for the strong form of the rational expectations hypothesis'.

2. THE MODEL

In the next sections the role of information for educational choice will be illustrated by some simple models. In this section the general characteristics of these models are expounded.

In the models there are two schools, called A and B, between which students have to make a choice at a given moment in their life. They have to make the choice, so it is not possible not to go to school and it is not possible to visit both or a mixture of the two schools. Once the decision is made, it can not be revised.

Further it is assumed that there are also merely two jobs, also called A and B. It is necessary to have a school A diploma to get a job of type A and to have a school B diploma to get a job of type B. This assumption does not mean that there is no substitution possible between labour with a school A diploma and labour with a school B diploma, but is actually a definition of the term job. Employers can still substitute between the two types of labour by shifting the ratio between the two types of jobs.

Students choose the school for which their utility is maximal. The utility student i will obtain by choosing school A or school B is described by

$$U^A_{Ei} = U^A(a^1_{Ei}, \ldots, a^n_{Ei}; w^A_E , p^A_E) \qquad (2.1)$$

and

$$U^B_{Ei} = U^B(a^1_{Ei}, \ldots, a^n_{Ei}; w^B_E , p^B_E) \qquad (2.2)$$

[5]

The utility function is the same for every student. Individual differences are brought into the model by making the utility depend on both individual characteristics

$$(a^1_{Ei}, \ldots, a^n_{Ei}),$$

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5. The two utility functions can be seen as derived from one universal utility function, which also depends on the characteristics of the study and job. Because these characteristics are taken constant in this model they are not a variable in (2.1) and (2.2).

and on labour market characteristics,

w_E^j (the wage of job j) and p_E^j (the probability to get a job).

The subscript E refers to the fact that the expected utility depends on the expected values of the variables mentioned. The relation between these expected variables and 'real world' variables depends on the information a student has. These relations will be introduced in the next sections.

For convenience the utility function depends only on one wage and one probability. The possibility of changing wages during a working life are neglected. This can be interpreted by the assumption that the working life has a length of one period.

As mentioned before the students will choose the school which leads to the highest expected utility, so if the choice is denoted with a s:

$$s_i = A \quad \text{if} \quad U_{Ei}^A > U_{Ei}^B \tag{2.3}$$

and

$$s_i = B \quad \text{if} \quad U_{Ei}^A < U_{Ei}^B \tag{2.4}$$

The individual characteristics of student i are considered as a draw from a continuous distribution function:

$$a_i^j \in A^j \quad [6] \tag{2.5}$$

For reasons that will be explained in the section 6 the n characteristics are distributed independently.

If the number of students which has to make the choice (say N) is large enough, the number of students choosing A can be approximated by

$$S^A(w_E^A, p_E^A) = Pr\{ U^A() > U^B() \} \cdot N \tag{2.6}$$

In which the utility functions contain the same argument between the

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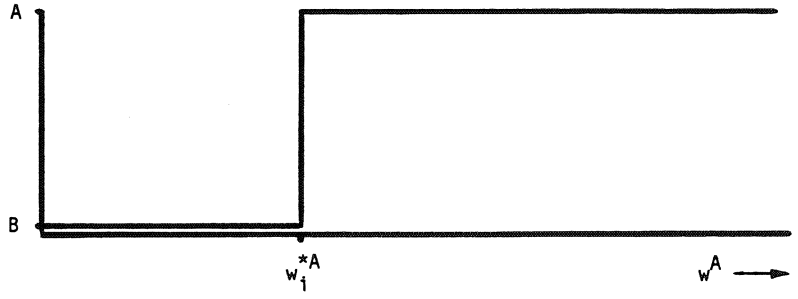
6. The $a \in A$ denotes that a has the probability distribution function A.

brackets as above, except for the fact that the individual characteristics are the stochastic functions and not their realizations.

Figure 1 illustrates the choice of one student as a function of the wage of job A, taking all the other variables constant. At wage w^* the utilities for both studies are equal. If the wage is higher than this 'break-even-wage' the student will choose A; If it is lower he will choose B.

Figure 1: The choice of student i as a function of the wage of job A.



Because the break-even-wage depends on personal characteristics, it is not the same for everybody. The number of students choosing study A is equal to the number of students for who the wage exceeds their break-even-wage. For 10 different students, this leads to the situation depicted in figure 2. Figure 3 shows the situation for an infinite number of students whose break-even-wages are normal distributed.

Figure 2: The fraction of 10 students choosing A

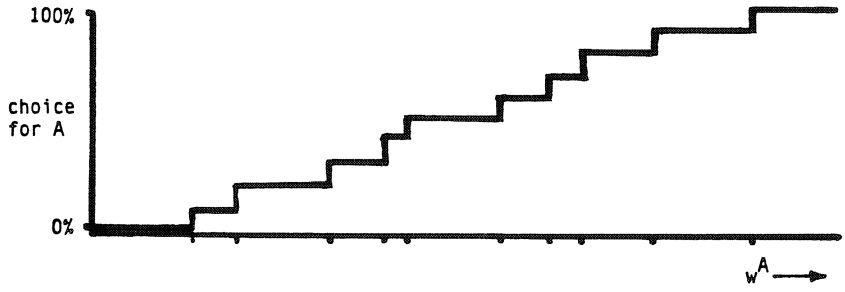
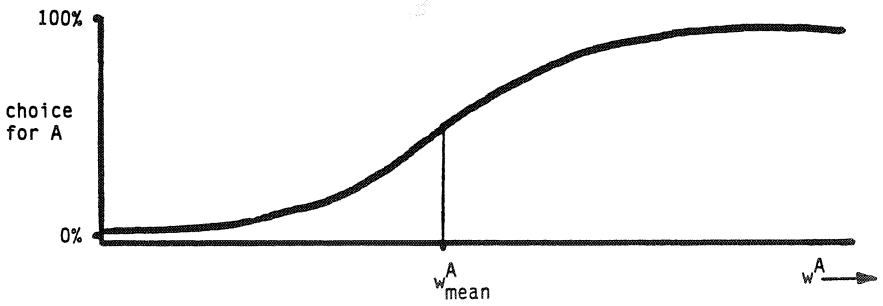


Figure 3: The fraction of students choosing A, with infinite many students and normal distributed characteristics



3. THE ROLE OF INFORMATION

When talking about the role of information in educational choice, it is necessary to go into the meaning of 'information' in this context. Most economic studies use the following concept of information. They start with an economic theory like Debreu's *Theory of Value* (1959). In this theory economic agents make decisions, e.g. on what to buy. They choose the alternative which optimizes their utility. An essential assumption in this kind of theory is that the economic agents know the utility which will be achieved by every possible decision. This assumption is released by the common theories of economics of information[7]. Their view can be illustrated by an example (figure 4).

Figure 4: Consequences of several choices in different states[8]

decision	state 1	state 2
school A	100	0
school B	50	50

Somebody has to make a choice between alternatives A and B. Instead of knowing the exact consequences of both decisions, the theory assumes that he knows there are two possibilities, called state 1 and state 2. For both states he knows the consequences, but he does not know which state will occur. In the model different states might refer to different 'states of the nature', but also to different utility valuations. In the last case the actor is not sure about the utility he will derive from different choices, so he distinguishes several possibilities.

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7. For example Theil (1967) and Drèze (1988).

8. Tversky and Kahneman (1986) show that in a model of this kind four assumptions are made which are not without opposition: cancellation, transitivity, dominance and invariance. These problems are neglected here.

Interpreting the figures in the matrix as gains, it is clear A would be chosen in state 1 and B would be chosen in state 2. In both states the cost of a wrong decision (based on a false belief) is 50. The central question of economics of information is: what is the value of having the information which state will occur?

This value can not be calculated without extra information. Because a posteriori the maximal loss is 50, it is evident that the value does not exceed 50, but that is all that can be said about it. The value depends on the probability a state will occur. Suppose a person has a subjective prior probability distribution on the various states. The best way for him to valuate perfect information is to use these subjective probabilities. Given that his prior probability of state 1 is equal to 80% and of state 2 equal to 20% (figure 5), then without extra information he will choose A, giving him a 20% chance of losing 50 so the costs are 10. These costs are equal to his value of the information.

Figure 5: A subjective probability distribution

decision	state 1	state 2
prob.	80%	20%
school A	100	0
school B	50	50

Notice that the subjective probability function has a double function. On the one hand it is used to calculate the optimal decision, i.e. the decision with the highest expected value. This expected value (EV) is the result from weighing the possible outcomes (U) with their subjective probability (p).

$$EV^j = \sum_k p_k^j \cdot U_k^j \qquad (3.1)$$

j is the index for the decisions (school A, school B);
k is the index for the states (state 1, state 2).
In this example

$$EV^A = 0.8 * 100 + 0.2 * 0 = 80 \tag{3.2}$$

$$EV^B = 0.8 * 50 + 0.2 * 50 = 50 \tag{3.3}$$

Without further information the agent will choose the alternative with the maximal expected utility, so he will choose school A. More in general, the choice J is such that

$$EV^J = \underset{j}{MAX}\ EV^j \tag{3.4}$$

On the other hand, the subjective probability function indicates the chance complete information will predict a certain state. The value of perfect information (VOI) depends on its contents. For a certain state it can be defined as the value of the optimal decision in that state, minus the value without the certain knowledge.

$$VOI_k = MAX\ U_k^j - U_k^J \tag{3.5}$$

In this example,

$$VOI_1 = 100 - 100 = 0 \tag{3.6}$$

$$VOI_2 = 50 - 0 = 50 \tag{3.7}$$

If the student gets perfect information, which tells him state 1 will be the case, he hasn't won anything, because his decision will not change due to the extra information. If, however, the perfect information tells him state 2 will be the case his gain is 50, because now he can anticipate this state by changing his decision from school A to B.

The state the information will predict, however, is not known beforehand, so

a student has to calculate the expected value of perfect information (EVOI), which can be calculated by again weighing with the subjective probability distribution.

$$EVOI = \sum_k p_k \cdot VOI_k \qquad (3.8)$$

Thus, a subjective probability function which assigns a too high probability to the one, and a too low probability to the other state, will have two effects. The student will too much emphasize the consequences in the first state (because he overestimates the probability this will occur), and he will underestimate the value of extra information, because he underestimates the probability that there will be a deviation from his expectations.[9]

Remarkable in this *theory of information* is the fact that an agent is assumed to have a lot of knowledge: He knows the possible states, he knows their consequences and he has a prior probability distribution on the states. The theory does not only show that in a case of imperfect information, this information gets a value, but above all makes clear that economic decisions, even the decision whether or not to buy information, presuppose information. The knowledge about the possible states and their prior probability refer to knowledge about the functioning of the (economic) world; The knowledge about their consequences refers to knowledge about the significance of several states for somebody.

A trivial example of the first aspect is that information on wages only has value for people who know that with a certain positive probability wages differ. For the second aspect knowledge about the significance of the wage for a certain person is needed for valuating the information. In the example

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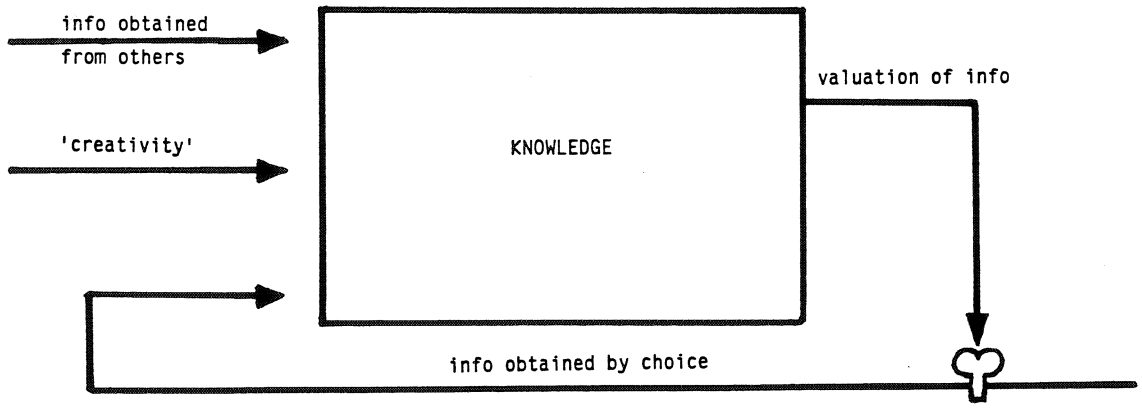
9. Lindley (1985, p. 131) shows that relevant information always has a positive value. A problem with his approach is the fact that he ignores the difference between subjective and objective probability. Drèze (1988, pp. 105-112) gives some exceptions of this 'value of information'-theorem. These occur in cases where people's decisions depend on each others.

   Some writers (e.g. Grossman and Stiglitz, 1976) work out the possibility to obtain the information indirectly by watching the behavior of others, who bought the information. Of course, such an opportunity for free-riding influences the value.

of figure 5 this can be illustrated by taking the subjective probability that state 2 will occur equal to 0%. The agent will certainly choose A and the value of extra information is 0 to him. However, there is no reason to assume that the subjective probability equals the objective probabilities, but in this situation the agent will never decide to purchase extra information as long as it is costly. His myopia can only be cured by information from others.

Because everybody starts his life without any information, it is not unlikely that this problem will occur. In order to develop, the agent has to receive information not caused by an economic decision made by him, to purchase this information. On the one hand this can be obtained by non-economic behavior or by chance. On the other hand he can get the information, not because of his own decisions, but because of economic decisions of others. Examples of these are publicity and upbringing.

Figure 6: Several sources of information



The different sources of information are illustrated in figure 6. There are two initial sources of knowledge: information obtained directly or indirectly from others and information obtained by creativity[10]. This is an essential condition to obtain the third kind of knowledge: information obtained by choice. This information can only be obtained by a personal decision, which is based on knowledge already at the disposal of the agent. With his available information he valuates new information and decides to open a tap.

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10. Hogarth (1980) pays much attention to creativity as an input for knowledge in chapter 8.

As often, this diagram is a large simplification. Most examples of information acquisition can not be reduced to one of these categories. For example, attending school may be based on an economic choice, but the results are a mixture of information obtained from the teacher and from the creativity that is stimulated by the school.

Some interesting aspects about information can be concluded from these analysis. Firstly, not all the information a person has, can be obtained by his own rational choices. There always is some prior information needed before someone can make a valuation of obtainable information. Another conclusion is that it is very unlikely that the picture somebody has of his choices and their consequences will ever be complete. This can lead to a situation in which somebody underestimates the value of information. The last conclusion is that the influence of others on the knowledge seems to be large, and as a consequence, the choices of somebody will be influenced intensively by the behavior of others.

These characteristics of information will be more important for an analysis of the choice of education than for e.g. portfolio choices at a share-market. At the last, possible states, their consequences and the purposes are much better known, because of the institutional character of a shares company. Education, conversely, is typically characterised by lack of knowledge. The reason to attend school is to obtain information (and skill), so a clear picture of the consequences of attending a school is a contradiction in the nature of things. This is neglected by the human-capital theory which looks upon education as a (one-dimensional) kind of material. More years of education just stand for more 'capability-substance'. The student only has to decide how much of this costly good he will buy, in order to optimize his utility.

A number of implications of the theory can be illustrated by examples from the educational choice. The first is the visit of the kindergarten. No child will ever decide completely on its own to visit kindergarten because of its benefits. Many of them will even not know about its existence and those who do will not have a clear picture in their mind about its contents. This can hardly be called a choice. The child just goes because the parents tell him to do so. On the other hand will 'expected utility' be very sensitive for very vague information. An older sister who enjoys going to kindergarten

will make the little child also wanting to visit school.

This example is of course very extreme, but the same aspects occur in choices for schooling of elder children. Choice has to be made with only a rough picture obtained from every day experiences, gathered information and the behavior of others. Acquiring all the needed information is almost equal to attending the school. Certain kinds of information the student can not valuate himself, so he will not take them into account or he has to get it from others.

The last example is also an objection against the human-capital theory. Since education is more than just an amount of a certain 'stuff', it is not trivial anymore that the only effect of more education is more skill (or a higher productivity). The education will also change the view of the student, making things unattractive that were attractive before. This can be illustrated by students, who decide to follow a study to make it possible to get a certain job, but after they finish their study, do not want to get this job anymore. Their 'utility-function' has changed due to the education they received.

4. SOCIAL INFORMATION

In the model sketched above it is not irrational to behave like others do. Very often group behavior and the occurrence of crazes are described as stupid, but in a world of few knowledge, every piece of information has its value. If somebody has to choose between two alternatives, but he has no idea what the consequences will be or what will be the utility for him, it is rational to use the experiences of people who already made the choice and now undergo the consequences. This behavior presupposes correlation between the utility-functions of different people. This procedure can be extended by linking the utilities by means of personal characteristics.

Also the planned decisions of other people who also still have to make the choice might be an influence for somebody. If everybody, except he, makes a certain decision, he might wonder wether he overlooked some of the consequences of his decision.

A very simple illustration of the effects of the use of social information is given by the following example. Assume that students have to choose between two different courses given at the same moment, so they exclude each other. The students want to choose the course which gives the most insight. Because the students can not know on forehand which one of the courses is the best, they ask elder students who already attended one of the two courses to tell their experiences. They already compared their experiences with their colleagues and discovered that only 20% of the students was better off with course A while 80% was better off with B. What is, now, the best thing to do for a student who still has to make the choice and has no further information? Of course he should take course B, giving him a 80% chance of being better of.

A difficulty in this type of models, which will be presented in the next sections, is the fact that in the second period everybody has chosen course B, so no experience is obtained anymore about course A. The assumption that is made implicitly is that after finishing the school everybody is able, not only to observe the 'utility' of his own choice, but also the utility of the alternatives he did not choose.

Now, suppose that one of the students made in spite of this, a choice for A.

For example, he made a mistake, or by chance all of his elder friends preferred course A. For him the fact that all his colleagues make the other choice contains information. Apparently there is a reason known to them, but not known to him, which makes them choose differently. This fact alone might be enough reason to change the opinion, and he even might ask his colleagues for their reasons.

The mechanism described in the last paragraph has a stabilizing effect upon the aggregated choices. The vague and unsystematic information gets accumulated by it.

Due to this social information a situation in which somebody has to choose (almost) without information is excluded. A theory not using social information will predict a totally random choice for somebody who has no own information. Here, on the other hand, the worse a person is informed the more he shall rely on social information.

5. INTER-TEMPORAL INFORMATION

Last section was about the problems of valuating situations by using 'social information'. Hayek (1945) stressed that wages[11] (more general prices) contain such an information. 'It is more than a metaphor to describe the price system as a kind of machinery for registering change, or a system of telecommunications which enables individual producers to watch merely the movement of a few pointers, as an engineer might watch the hands of a few dials, in order to adjust their activities to changes of which they may never know more than is reflected in the price movement'.[12] It is not realistic to assume every student (or even somebody) knows all the benefits of a certain course. This information is reflected in one figure, the wage. And in a world that is constantly changing, the usefulness of certain kinds of education also will change, so the future usefulness is best approximated by the latest wages.

From this point of view it is not strange that students take the present wage as an indication of the future situation, but there is a large difference with normal prices. That is the fact that there is no market for courses. Hayek states that a change in the prices makes people 'move in the right direction'[13], but due to the absence of a market this mechanism does not regulate the extend of this move in the right direction. In normal cases prices react to changes in supply or demand very fast, so an overreaction will be avoided. In the case of education a reaction is not possible before students enter the labour market, which often requires a number of years. This might lead to the cobweb-phenomenon.

The theory of rational expectations suggests that since students try to optimize their utility it is profitable for them to use better sources of information about future wages. However, without giving a sufficient explanation it was remarked in the introduction that such sources do not

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11. In this section the assumption is made that the only important figure for students about the labour market is the wage. Markets are always cleared so there is no unemployment. The analyses can easily be extended to the situation in which the probability to get a job plays a role.

12. Hayek (1945), p. 527.

13. Hayek (1945), p. 527.

exist. In the model in this section this observation is taken as a point of departure. As long as there is no optimal information about future wages, the present wage keeps the value that is explained above. Even if they are aware of the possibility of a cobweb-cycle, students might have advantage by using the present wage. Correcting this wage for the influence of the cobweb-cycle might be a difficult task, since this effect can not be separated from autonomous changes in the 'equilibrium wage'.[14] The term 'equilibrium wage' refers to the wage that would have occurred in the case of complete foresight.[15]

As mentioned in the introduction, several studies have been made into students reactions on labour market situations. Do students base their decisions on only the actual labour market situation, as if it were the future situation, or are their decisions influenced by future changes which can be identified already? It is remarkable that some of these studies find clear evidence for a rational expectations model (e.g. Zarkin, 1985), while others show that the behavior of students can be explained by a cobweb-model (e.g. Freeman, 1971). However, none of these studies attempts to test empirically between the cobweb model and rational expectations.[16] If both results are right, the coexistence of them needs explanation. This explanation can be found in different degrees of predictability of the future situation.

This explanation is supported by the fact that Zarkin's research (finding evidence for rational expectations) is about teachers, for who the demand is mostly influenced by the number of children and governments decisions. Zarkin himself states that 'this market has the special feature that future demand conditions can be readily forecast'.[17]

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14. In order to keep the model simple the possibility to correct the present wage for cycles is kept out the model. Past wages are not used as information, but they do take account of the fact that the observed wage might differ from the 'equilibrium wage'.

15. Kaldor (1934) defines complete foresight as: 'that everybody foresees correctly the future course of prices' (p. 123). The term is introduced by Hicks.

16. Zarkin (1983) is about cobweb versus rational expectations models, but it does not contain a test between these two alternatives.

17. Zarkin (1985), p.440.

Rational expectations theory assumes that every agent is able to produce the optimal model for the situation he is in. It is often remarked that this is a very strong assumption. If a student is not able to make his own predictions, or only very vague predictions, and this fact is taken for granted in this paper, he has advantage by using the experiences of others (in this case the wage they receive), who already entered the labour market, as an indication of the future situation. But, just like his own behavior is not based on his own predictions anymore, the same will be the case for other students. The quality of the current wage as an indication of the equilibrium wage is caused by the facts that the individual predictions are accumulated in this figure. If students make less use of their individual predictions in making their choices, the quality will reduce. The more students rely on these signals, the less reliable the signal they produce will be. This fact has to be taken into account by them. This might lead to an equilibrium between the use of one's own predictions and the revealed estimations of others. If everybody makes too much use of the aggregated information, this signal will lose its reliability, and if everybody almost only uses his own predictions the aggregated signal will become an useful source of information. The more accurate the personal estimations are, the more this equilibrium will tend to the use of own predictions and the more the aggregated behavior will tend to rational expectations behavior.

Assume that the present equilibrium wage, is an unbiased predictor of the next year equilibrium wage (not taking into account additional information).

$$w^e_{t+1} \,|w^e_t \in N(w^e_t , \sigma^2_1) \qquad (5.1)$$

The superscript e refers to the equilibrium situation: The wage that should be reached if everybody would have had complete foresight. Thus, this equilibrium wage is an indication of the labour market situation.

Further, it is assumed that students get an additional indication of future developments of the wages. Each student can get a different indication, but it is assumed that on average this index is correct. Calling this index S and taking a normal probability distribution, this leads to:

$$S_i \in N(w^e_{t+1} , \sigma^2_2) \qquad (5.2)$$

Every student has two sources of information at his disposal. The current equilibrium wage together with an indication how likely it is that this equilibrium will change and a vague indication of the future changes of this equilibrium.

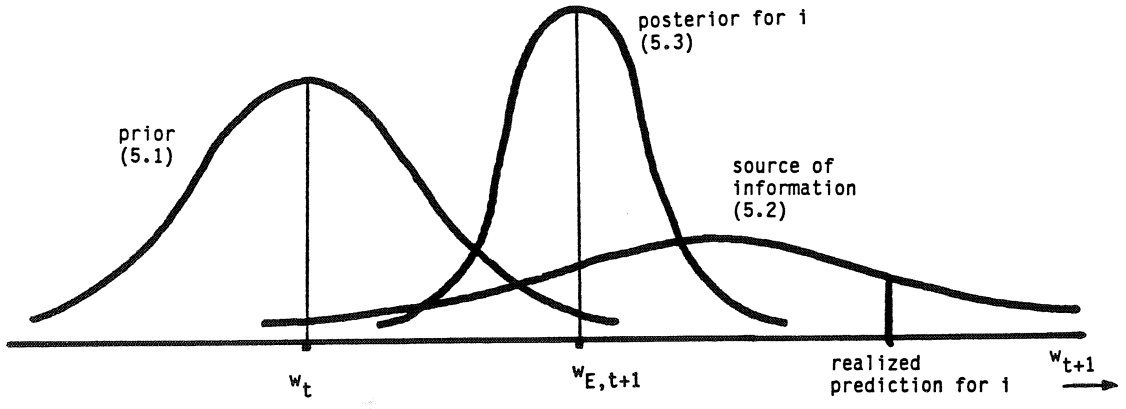
Using Bayes' rule, the prior distribution of the wage at t+1, given the equilibrium wage at t (formula (5.1)), can be transformed to a posterior distribution (5.3), using the additional information of (5.2). Using the property of conjunction it follows that

$$w^e_{t+1} \mid w^e_t, S_i \quad \epsilon \; N(\sigma^2 (w^e_t / \sigma_1^2 + S_i / \sigma_2^2), \sigma^2)$$

$$\text{in which } \sigma^2 = \frac{1}{1/\sigma_1^2 + 1/\sigma_2^2} \text{ , the harmonic mean.} \qquad (5.3)$$

This is illustrated in figure 7. Since the additional information is different for everybody (everybody has his own realization of the distribution (5.2)), also the posterior distribution differs among the students. If the variance of the prior distribution is relatively small, compared with the variance of (5.2) the posterior distribution will be close to the prior distribution: i.e. the students will almost completely take the current wage as an indication of the future wage.

Figure 7: The use of present wage and predictions of the future wage by a particular student.



If every student bases his decision on the expected value of this posterior distribution (i.e. the mean of this normal distribution), then the mean 'predicted wage' is equal to

$$w_{E,t+1} = \frac{\sigma^2}{\sigma_1^2} \cdot w_t^e + \frac{\sigma^2}{\sigma_2^2} \cdot w_{t+1}^e = \lambda \cdot w_t^e + (1 - \lambda) \cdot w_{t+1}^e \qquad (5.4)$$

Although the total population of students in fact has complete knowledge about the future (their mean expectations are equal to future realization), they use a mixture of their expectation and the present situation. This is due to the fact that students only observe their own prediction.

The assumption that equilibrium wages in the next year are normal distributed around the present wage is not essential for the model. The essence is that there are two types of sources of information. One type is observable by everybody without a measurement error (in this case the present wage), while the other type is observed differently by everybody, however in mean the observation is correct (in this example the future wage). If the measurement error of the second type becomes smaller, students will rely more on this (unbiased) source. On the other hand they will rely more on the first type if this source is a better predictor of future situation.

In the model sketched above it is assumed that the present wage equals the equilibrium wage. But, this presupposes the students expectations of wages to be unrelated with the realizations. Students observe the realized wage and not the equilibrium wage. This causes an extra error in the predicting power of the present wage.

$$w_t = w_t^e + \epsilon_3 \qquad (5.5)$$

This error term has a variance:

$$\sigma_3^2 = (\sigma_1^2 + \sigma_3^2) \cdot \lambda \cdot \frac{E_{supl}}{-E_{dem}} \qquad (5.6)$$

or explicitly:

$$\sigma_3^2 = \sigma_1^2 \cdot \frac{\lambda \cdot C}{1 - \lambda \cdot C} \qquad (5.7)$$

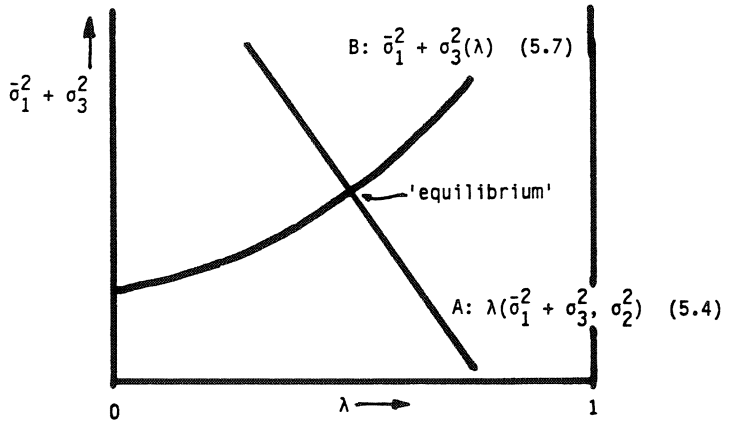
In which E stands for the elasticity of respectively supply and demand and C is the negative ratio of these two. The variance of the bias is equal to the variance of the difference between the present wage and the future wage, times the degree in which the present wage is used in predictions times the oscillations factor of the cobweb model.[18] [19]

In the model formula (5.1) has to be changed into

$$w^e_{t+1} \mid w_t \in N(w^e_t , \sigma_1^2 + \sigma_3^2) \qquad (5.8)$$

Now, the variance of this equation depends on λ, while λ depends on both the variance of the prior distribution and the variance of the measurement error of the future expectation (see formula (5.4)). This is illustrated in figure 8. In this illustration λ and σ_3^2 are taken variable, while σ_1^2 and σ_2^2 are taken fixed (indicated by a bar).

Figure 8: The equilibrium between the use of the present wage and its reliability.



Individual information is aggregated optimal if $\lambda = 0$. In that case students only use their predictions and not the future wage. In figure 9 different levels in which individual knowledge is aggregated, are indicated. The curves represent 'iso-use-of-information curves'.

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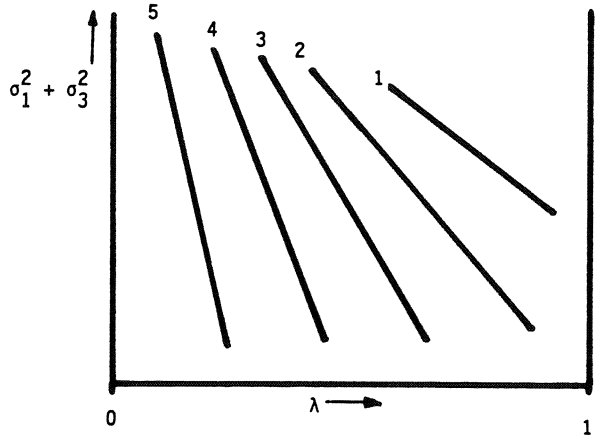
18. Nerlove (1958), p. 229.

19. In this model students do not use the information contained in wages before period t. These could help them to make a better distinction between changes in the equilibrium wage and cobwebs.

Figure 9: 'Iso-use-of-information curves'



If students predictions about the future wage become more accurate (σ_2^2 becomes smaller) curve A will shift to the left, because they make more use of their own predictions, and this causes the present wage to be a better predictor (see figure 10). Both effects improve the aggregated information.

Figure 10: A decrease of σ_2^2

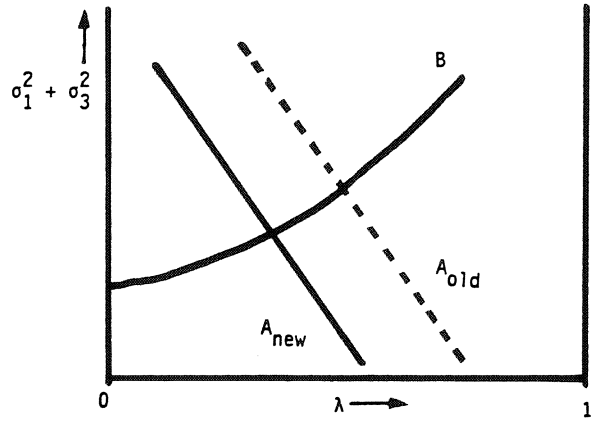
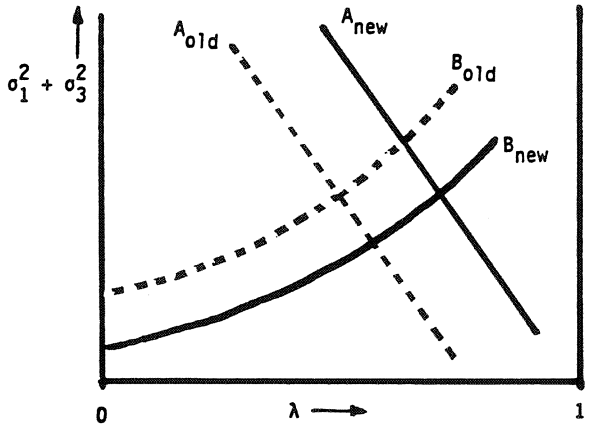


Figure 11: A decrease of σ_1^2



A decrease of variance 1, will shift curve B down, which has a positive effect upon the use of aggregated information, but this positive effect will be reduced by a shift of A to the right. Students will more rely on the present wage (see figure 11).

6. UNCERTAINTY ABOUT THE ATTRACTIVENESS

In the introduction the difficulties of educational choice were indicated. The consequences of the choices students make depend on aspects which can not be completely known to them, (1) because they are future and (2) because students do not have experience with them. In this section the second problem will be illustrated by a model in which the students are not completely informed about their own characteristics. They do not know in advance wether they will like certain aspects of their future job or not.

In the model of section 2, the utility functions are assumed to depend on two individual characteristics and on the wage. Just like in section 5, full employment is assumed, so the probability to get a job does not matter.

$$U^A_{Ei} = U^A(a_i , b_{Ei}; w^A) \tag{6.1}$$

and

$$U^B_{Ei} = U^B(a_i , b_{Ei}; w^B) \tag{6.2}$$

The first individual characteristic represents all the information a student has about himself and the second represents all the information that is not known to him. This interpretation justifies the assumption that the two characteristics are not correlated. Because, if they were correlated the knowledge of the first would induce information about the second characteristic. Both characteristics are assumed to be normal distributed among the students:

$$a_i \in N(\bar{a} , \sigma^2_a) \tag{6.3}$$

$$b_i \in N(\bar{b} , \sigma^2_b) \tag{6.4}$$

To simplify the analyses the utility functions are taken linear such that

$$U^A_i - U^B_i = a_i + b_i + w^A - w^B \tag{6.5}$$

Now, the effects can be derived straightforward. In figure 12 two situations are compared. Curve 1 represents aggregated choice for A as if

$$S^A = Pr\{ U^A - U^B > 0 \} \cdot N \qquad (6.6)$$

and because of (6.3), (6.4) and (6.5)

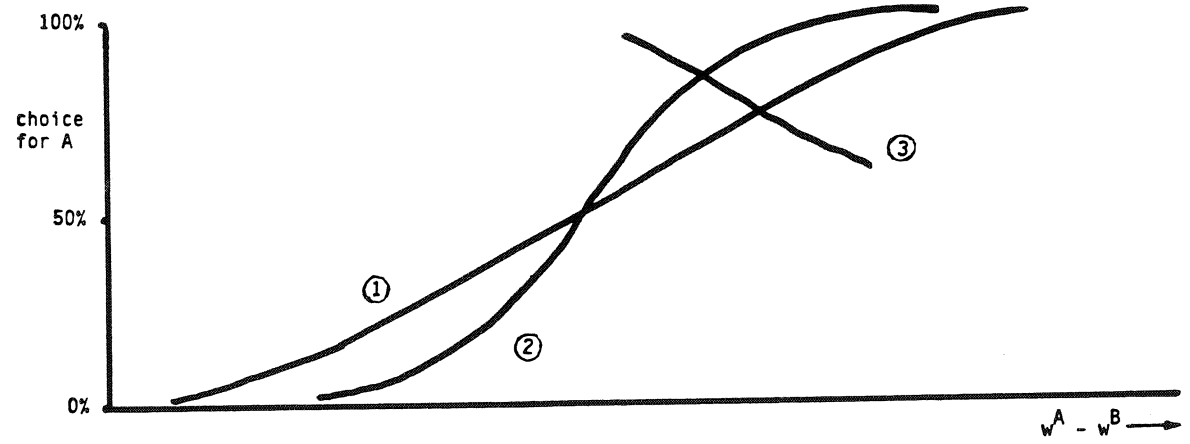
$$U^A - U^B \in N(\bar{a} + \bar{b} + w^A - w^B , \sigma_a^2 + \sigma_b^2) \qquad (6.7)$$

so

$$S^A = 1 - \Phi(- \frac{\bar{a} + \bar{b} + w^A - w^B}{\sigma_a^2 + \sigma_b^2}) \qquad (6.8)$$

[20]

Figure 12: Supply in case of complete (1) and incomplete (2) knowledge and a demand curve (3)



Curve 2 represents the same aggregated choice for A, but now under the assumption that students do not now their own characteristic b, and in stead of this, approximate their utility (which includes the unknown b) by the expected value it. Because the utility function is linear this is mathematically the same as replacing b by its mean. This leads to

$$U^A - U^B \in N(\bar{a} + \bar{b} + w^A - w^B , \sigma_a^2) \qquad (6.9)$$

because everybody will use the same b now. So,

$$S^A = 1 - \Phi(- \frac{\bar{a} + \bar{b} + w^A - w^B}{\sigma_a^2}) \qquad (6.10)$$

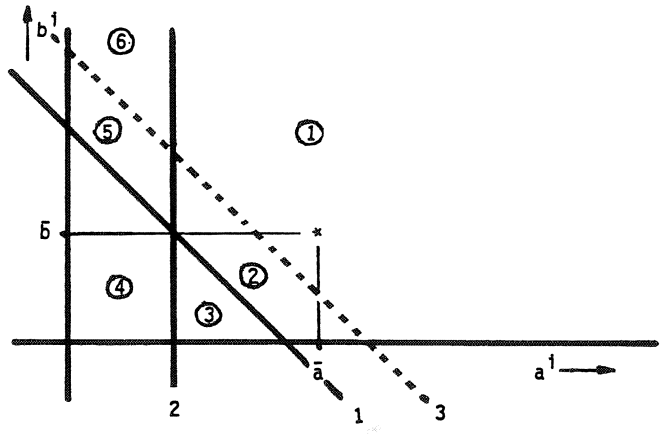
---

20. Φ denotes the cumulated density function of the standard normal distribution.

Figure 12 shows that in the case with incomplete knowledge the wage elasticity of the supply increases. Curve 3 represents a demand curve. In this case (the demand for A is bigger than the demand for B) students choosing A get a lower wage in the situation with incomplete knowledge compared with complete knowledge. Just like the example in section 4 the fact that a majority of the students prefer A to B makes all of them overestimate the utility of A. This leads to an increase in supply and consequently to a decrease of the wage.

Figure 13 illustrates the types of errors that occur due to this incomplete knowledge. The two individual characteristics are set out on the axes, so every student, who has a particular combination of these two characteristics, is located somewhere in the plane (* is the student with the mean characteristics). Curve 1 represents the break-even-curve if students had complete knowledge. Because they do not have complete knowledge they have to estimate characteristic b by its mean. The break-even curve in this situation is depicted by curve 2. Students in area (1) and (2) choose A and students in area (4) choose B in both cases. They do not make a mistake due to the lack of information. However, students in area (3) choose A instead of B and students in area (5) and (6) choose B instead of A. Even if the aggregated supply under incomplete knowledge equals the supply with complete information these errors occur.

Figure 13: The different types of errors in choice



Because it is assumed that students observe their utilities when they have finished school and enter the labour market, they will discover their error. The wage that is reached in the situation with incomplete knowledge does not equal the wage that would have been reached with complete knowledge, so the

break-even-curve that is observed (curve 3) is not the same as curve 1. So, students in area (2) observe that they erroneously chose A, while in fact their choice was right if everybody had had complete knowledge. Students in area (5) do not observe their error.

7. CONCLUSIONS

In order to get an optimal allocation all the relevant information which is available in the society should be used. Hayek (1945) stated that it is unrealistic to assume that everybody knows everything when he has to make an economic decision. In his view people have, in contrary, only very few information, but due to the market system all the information gets aggregated. Market prices reflect all this relevant information.

This paper started with the observation that a school-market does not exist. At such a school-market students are matched with courses in order to obtain an optimal allocation on the future labour market. It is difficult to explain the absence of this market , but perhaps a reason can be found in the fact that students are still very uncertain about their capacities and 'utility'.

Because of this absence no optimal prediction of the future labour market situation is available and for that reason certain sources of information become informational valuable. In section 5 it is shown that the present wages (and also the present probabilities to get a job) can be used by students in order to improve their expectations. This in spite of the fact that they know that this source of information causes biased predictions. Although the total population of students, together, has perfect foresight (which is assumed by the model), this information is not used optimal by the students. They are not able to aggregate the available information.

In section 6 a second example is given in which students do not have complete knowledge of their own utility function. To fill this gap they compare their own situation with people who already have experience at the labour market. In this model students tend to estimate their utility by the average utility. This causes that too much students choose for the 'popular' direction, i.e. the direction which are preferred by most students. In this case the predictions of the students are also biased, but again the students do not have the information that is needed to avoid this bias.

The models which are used in this paper are very simple, so it would be to pretentious to draw practical conclusions. On the other hand they show that some types of economic behavior, such as 'cobweb-behavior' and group

behavior, which are often described as stupid or myopic, can be explained departing from the assumption of rational behavior.

REFERENCES

Debreu, G. (1959), *Theory of Value*. New Haven.

De Jong, E. (1988), 'Expectation Formation: Criteria and an Assessment'. *De Economist*, 136-4, pp. 435-467.

Dothan. U. and J. Williams (1981), 'Education as an Option'. *Journal of Business*, 54-1, pp.117-139.

Drèze, J.H. (1987), *Essays on Economic Decisions under Uncertainty*. Cambridge.

Freeman, R.B. (1971), *The Market for College-Trained Manpower*. Cambridge, Mass.

Freeman, R.B. (1976), 'A Cobweb Model of the Supply and Starting Salary of New Engineers'. *Industrial and Labor Relations Review*, 30-2, pp. 236-248.

Grossman, S.J. and J.E. Stiglitz (1976), 'Information and Competitive Price Systems'. *American Economic Review*, pp. 246-253.

Hayek, F. (1945), 'The Use of Knowledge in Society'. *American Economic Review*, 35-4, pp. 519-553.

Hogarth, R. (1980), *Judgement and Choice*. Chichester.

Kaldor, N. (1934), 'A Classificatory Note on the Determinateness of Equilibrium'. *The Review of Economic Studies*. 1, pp. 122-136.

Kantor, B. (1979), 'Rational Expectations and Economic Thought'. *Journal of Economic Literature*. 17, pp. 1422-1441.

Lindley, D.V. (1985), *Making Decisions*. London.

Muth, J.F. (1961), 'Rational Expectations and the Theory of Price Movements'. *Econometrica*. 29-3, pp. 315-335.

Nerlove, M. (1958), 'Adaptive Expectations and Cobweb Phenomena'. *Quarterly Journal of Economics*. 72, pp. 227-240.

Siow, A. (1984), 'Occupational Choice under Uncertainty'. *Econometrica*. 52-3, pp. 631-645.

Snippe, J. (1986), 'Varieties of Rational Expectations: their Differences and Relations'. *Journal of Post Keynesian Economics*. 8-3, pp. 427-437.

Theil, H. (1967), *Economics and Information Theory*. Amsterdam.

Tversky, A. and D. Kahneman (1986), 'Rational Choice and the Framing of Decisions'. *Journal of Business*. Supplement, pp. 251-278.

Wiegersma, S. (1961), *Psychologie der beroepskeuze*. Utrecht.

Zarkin, G.A. (1983), 'Cobweb versus Rational Expectations Models'. *Economics Letters*. 13, pp. 87-95.

Zarkin, G.A. (1985), 'Occupational Choice: An Application to the Market for Public School Teachers'. *Quarterly Journal of Economics*. 100, pp. 409-446.

Publicaties/Publications ROA

Rapporten/Reports:

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